

1926 *Handers Inn*
DIFFERENT PLANS

FOR IMPROVING THE

HARBOUR of BRISTOL,

IMPARTIALLY EXAMINED:

AND A MODE POINTED OUT OF EMBRACING
ALL THE ADVANTAGES, WITHOUT THE RISK
OF AFFECTING THE HEALTH OF THE
INHABITANTS, OR INJURING
THEIR PROPERTY:

By J. T. *K*



W.C.C.
BRISTOL:

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1800.

DIFFERENT PLACES

THE INTERIOR OF THE

THE FOUR V. BRISTOL

THE HARTLEY LEANING

AND A MORE POINT OF VIEW

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IMPROVEMENT OF THE HARBOUR,

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A LETTER printed and circulated some time in the present year, but dated the 23d of November, 1799, signed '*A Citizen*', appears to me to be intended to revive a spirit for improving the Harbour of Bristol.

The plan described is for making a Dock in Canon's Marsh, and is worthy the examination of every person interested; as the disadvantages this Port labours under (explained in this letter) are obvious to all.

Another letter follows this, dated 20th of August last, signed '*A Well-wisher to the City and Port of Bristol*,' which states many reasons why our trade is declined, and laments that not the least attempt is made to improve the Port, or revive the trade of this city. Then says—"the plan of improving the Harbour, and the report given in to the Society of

“ Merchants, by Jessop and White, prove that
 “ it is not impossible to fleet the Avon, and
 “ removes or answers all the objections that
 “ can be made.”

These letters, and a notice in the Papers for going to Parliament, have led me to examine what may be the consequences attendant on either of these Plans, and to put my observations on paper; and should they in any way throw light on the subject, either by convincing those who may not have much considered or weighed the matter, or by throwing out any thing that others may mature or confute, my end will be answered.

These two Plans, as far as I can trace back, appear to be proposed by Smeaton in 1765, and Wm. Champion in 1767. The first is to wall or bank up the end of the Frome, dig a new canal 100 feet wide, and drop the tail of it into the Avon at the bottom of Canon's Marsh, just above the Glass-house, through a Chamber capable of holding eight ships, with sea and land gates; this canal to birth 24 ships, and to be widened if more births were thought necessary. His estimate 25,000*l.* exclusive of purchase of lands and damages to Bridewell Mill and Toms's Dock.

This Plan has been imitated with variations by many since, and suggested by others who have not seen Smeaton's, nearly in the same way, and generally proposed wider, as he recommends. Several of these Plans have come within my notice, some are very crude, but as Smeaton is the first I can find, I shall consider this as his scheme.

The second by Wm. Champion seems to be set up in competition in 1767—(as the second letter I have alluded to is to the first)—and is for damming the river at the Redclift, which he proposed doing in different ways at various prices, from 30,000 to 37,000*l.* but estimated by Milne at from 55,000 to 65,000*l.* This is nearly the same that is said to be recommended by Jessop and White; the only difference Jessop has placed his canal at a greater distance from the river, it is longer, the chamber more convenient, and more expensive.

I may acknowledge that frequently when I have seen a high tide in fine weather, without any land-flood in the river, it has struck my mind as it has many others, its a pity we cannot preserve this beautiful appearance, as well as convenience for removing ships at pleasure;

and regret to see the water retreat and leave a channel covered by mud in its place ; but however gratifying to the imagination, and though I think with Jessop and White, it is possible ; I wish to consider whether it is prudent to effect it.

The advantages of damming the river, provided the depth proposed be sufficient, are

6 The ships floating at the present quays so as to land the goods in situations *adapted* to the warehouses now built, without prejudicing private property ; and convenience of moving them from place to place at pleasure.

Against this plan the following objections and difficulties have been urged :

1. The destruction of Mills on the Avon and Frome.

2. The great Land-floods.

3. The Frosts.

4. The overflowing of the Gouts, and also damages to Houses and Lands.

5. Not being able to get Ships up and down as at present.

6. Sea-water mixing with River-water.

7. Health of Inhabitants.

8. Counter Currents.

First,—*Mills.* The height intended to dam the rivers by this scheme is 15 feet, by a gage placed at the lower birth on the Quay ; 10 feet 7 inches at the Drawbridge ; 6 feet 5 inches at the Stone-bridge. I observe when tide is down to this mark, loaded ships are generally a-ground.—Where docks have been built 18 to 20 feet deep, and where they are not so liable to fill up with mud and filth as at Bristol, they are going to build the next deeper. It may be said the bed of the Frome may be lowered, and also of the Avon ; so much as it can be lowered should be allowed for accumulation of mud, as opportunities will often be wanted to scour and cleanse. But I shall confine my observations to the 15 feet deep on Jessop's section.

There seems to be a great variation in the levels, taken or described by different persons. Smeaton says his 15 feet mark on the Quay gage is about 6 feet below the top of the Quay. Jessop's section is 9 feet. Smeaton says his level is 4 feet below a high tide, in January 1765. Jessop's section is 9 feet below his high tide in January 1792. I therefore conclude this gage has been moved in the course of 27 years, and that Smeaton has 3 feet more water than Jessop.

Wm. Champion says there will be "no more
 "water at Hanham Mills than at present";
 but on Mylne's reporting Hanham Mills will
 be ruined, Champion says "I have some hope
 "to the contrary, but cannot *assert* it till the
 "spirit level now undertaking, has determined
 "the altitude at the Water-Works and Han-
 "ham Mills."

Ames Hellicar says the water will be bayed
 back, nearly to the turnpike on the Bath road.

By an accurate survey of the river Avon
 from Bristol upwards, in 1796, by Greame, he
 makes the fall from the top of Hanham Wier
 to the bed of the river at Bristol bridge 16 feet.
 And Jessop's section makes his floating level
 16 feet 6 inches at the bridge; by this it appears
 that the level of 15 feet on the Quay gage,
 is 6 inches above Hanham Dam.

Again, the explanation of Jessop's plan given
 by the Corporation and Society of Merchants,
 in speaking of the objects beyond the plate,
 (which goes only to Temple Backs) says, the
 average level of the water in the bason will be
 about 4 feet under Hanham Weir.

Being rather at a loss to determine the levels,
 I have made many observations on the flowing

of the tide at the Quay and Hanham, at different heights; and I find a tide 15 feet at the Quay is $2\frac{1}{2}$ feet under the top of Hanham Weir in moderate weather. Now opinions are various respecting the flow of the tide, whether the velocity of the water rises it so high at Hanham as at Bristol Quay, or not. If we take into consideration the very short turns in the river, particularly at Conham, it will be clear that neither the velocity of the tide, nor the effect that the wind has upon it, can rise it higher or so high at Hanham. Nothing but the weight of water can effect it, and the tide is turned at Bristol near half an hour before it is high water at Hanham.

Instances may be brought of the tide rising higher, for a mile or two, up a river than the level at the mouth; but this is occasioned by the first contraction, and farther up these rivers, after passing the windings in it, the effect ceases.

The highest tide we have had for the last twenty years, was on the 30th day of October, 1795; this rose 7 feet over Hanham Weir, and within 2 inches of the top of Keynsham Weir. A level was taken from the mark of this tide at Hanham, to the mark at Bristol Quay, and the latter was found 1 foot 9 inches

higher than Hanham. If the level was correct, there are 21 inches more height required at Bristol to press this tide on to Hanham; which would also make Hanham Weir and proposed Dam mark nearly level. But I will take the average between this and the Merchants' report; I shall then have the top of Hanham Weir, about 2 feet above the floating level. It is 8 miles from Hanham to Redclift, the fall at present in the usual run of the river is 17 feet; if I then allow it to be 4 feet only (for we must consider this Pond to have a current) that throws the river 2 feet over Hanham Weir, and will ruin Keynsham Mills, unless they are altered to work with 3 feet water instead of 5, (which will make them of very small value) and then every storm of rain will be stopping them, for want of the water passing off quicker between Hanham and Shatford Shoal. And suppose I allow that the Merchants' account of level is right, giving 4 feet current for water between Hanham and Redclift, makes it level with the Weir, and this part of the river being filled with dead water, will keep back the least swell of the river so as to affect the mills at Keynsham, both on the Avon and Chew.

** 15 Inches under Hanham weir*

Secondly—*Floods.* Before I enter on this subject, it will be necessary to consider the construction of the Dam proposed, and the room left for this heavy body of water to pass off.

Those who have meant to pass off this part of the subject by a joke, and without examination, are unfortunate in comparing this scheme to Wiers or Dams already on the river. They have not considered how jealous every Mill owner is of the next below him, raising his Dam even a single inch; indeed a Suit it now depending where the encroachment, if any, will probably be found not to exceed two inches perpendicular. All these Wiers are known to increase the Floods in the meadows, and are generally about 6 or 7 feet high; whereas the projected Dam is 27 feet high to the floating level on the East side, and 40 feet on the Sea or West side.

It is proposed that the East side should be built to within 3 feet of the floating level, or intended regular height of the water; with falling doors for these 3 feet, in 36 apertures of 6 feet wide, besides 4 apertures of 12 feet square, through the whole building.

two on each side the river. The West or Sea side of the Dam, which is to have a roadway over it, is to be 16 feet higher than the other; the distance of 20 feet between these two being built only to within 14 feet of the East side, to catch the water falling over this part; and the western part has 6 apertures each 12 feet wide and 12 feet high; the building being solid above and below this 12 feet, and also 24 feet solid building between each aperture; so that here is 72 feet in breadth and 12 feet in height for the water to pass through, immediately after the Dam has broke the force of the current, (the tops of these apertures being 2 feet under the top of the Dam) with the addition of what may be got off by the flood-hatches on each side the river, at the ends of the Dam, through the whole building of 70 feet thick: these will not take so much water as if they were further in the river, and the timber will occupy a great deal of room as it must be stout; though we may value on the pressure of the water above, we must consider that the other 6 apertures will be full of water, discharging in the middle of the river at the same time; and the tail will

only be 5 feet under the intended level of the head: we will therefore value on these four as on the other six, the whole space then is 120 feet wide and 12 feet high.

Doubtless the Engineer contrived this Dam to take the quantity of water that has been stated to him to be necessary; but whatever may be the abilities of an Engineer, his opinion in a country with which he is not particularly acquainted, must be principally founded on the information given him, which in the present instance appears, from the following observations, incorrect.

By his sections the description of the common current of the river at the bridge is $3\frac{1}{2}$ feet water, and his high flood about 5 feet more, below the bridge to Redclift the common current is 6 to $6\frac{1}{2}$ feet, and in his high flood 6 to $6\frac{1}{2}$ feet more; now reckoning the upper or additional 6 feet water to be twice as wide, there will then be three times as much space of the Channel filled with water in the flood as in a common current, though on examining his cross sections you will find it not quite so much. At the bridge the river does not widen, and the space is as $8\frac{1}{2}$ to $3\frac{1}{2}$. Now from my

observations at Hanham when the river is in its usual course, and no sluice open or Mill going, to carry any of the water off, it will not rise 6 inches on the Dam, but in a high flood will commonly rise 15 feet,* which is thirty times as high, and will spread with the same force over a withy bed and the Lock walls (4 feet higher than the Dam) about three times the breadth altogether. Here is more than fifty times the space. When its over the Wier there is 8 or 10 feet more depth in the river, but only the regular fall on the surface appears: in this as well as at the bridge there is also additional current.

Notwithstanding the water in the common current of the river at the bridge spreads nearly its breadth, I think it cannot average 1 foot, nor be more than 2 feet in the deepest place; the flood the 10th of this month (November) was within 1 foot of the springing of the arch, though not the highest that has been known on the Avon, yet a higher is not remembered

* It will perhaps occur to some of my fellow-citizens, that about 26 years ago there was a great flood; which rose near 17 feet at this place.

on the Frome. The most remarkable flood, (*viz*, that alluded to in the last note) rose nearly to some pieces of timber left in the wall belonging to the late temporary bridge, which is only 2 feet under the floating level.

I calculate the quantity of water passing at Hanham to be upwards of 40,000 tons per minute, it is said from 70 to 100,000 tons pass at Bristol-bridge in the same time; and any person may observe at the last mentioned place where is the strongest current of the river; though there are only two narrow piers to obstruct its passing, even these piers will raise the water more than 3 feet higher on the upper side than the lower; of course it will readily be conceived with what difficulty it must pass in 3 feet depth over a Dam divided into 36 parts, and at 20 feet distance get into holes 24 feet a-part, with but little pressure or current.

I would by no means be understood to insinuate the floods will not make their way through this critical passage, I have indeed little doubt that they will; yet what pressure will be necessary, and what the consequence of the head that must be raised just above the Dam?

I shall be under the mark when I say 4 feet higher than is allowed; for recollect the Dam or cascading is only 20 feet distance from the apertures the water is to pass.

Upon examining Jessop's longitudinal section; I find the current of flood from Temple Backs to the Dam 10 feet—By no means sufficient, as is evident from my former observations on the height of the flood at the bridge. I will however take half this, and add 5 feet to the 4 feet at the Dam, this will produce 2 feet water in the lowest part of Thomas-street; as the river will be a little higher opposite Temple Meads, these will be overflowed; and all Pilemarsh and the low ground in the out parish of Philip, on the other side the river, will be a great depth under water; besides the additional height it will be held back, while the tide keeps it from passing off even in this way; and how will it be when the river, by constantly being damed, becomes choaked up.

I am convinced there is no great difficulty in erecting a Dam to keep out the tide, for we know to what height that will rise; but a land flood, some of which has to fall 2 or 300 feet, down different rivers and here uniting in one;

that brings great part of the water of Wiltshire, as well as of Gloucestershire, and Somersetshire must have vent, or rise to a level that will force it; for it is not altogether the great fall of the country through which this body of water passes, that secures Bristol from overflowings, but the size of the river downwards; for a high tide makes one pond from the mouth of the river to Keynsham Mills 18 miles.* The greatest current is at Bristol.

At present when the tide begins to meet the fresh, there is $12\frac{1}{2}$ feet of water at the Redclift. Building the Dam will make 27 feet, and rising upwards to produce current; whilst the tide is at the doors of the Dam fastening them up, where can the land-flood go, but spread over the country; it must be so, even if the river was no more than full when the tide

* Wm. Champion says—"he has built two Dams at Warmly and Bitton over these run rapid floods." Now the floods from these two streams come into the Avon, and neither of them make up the hundredth part of the water that passes at Bristol. He says—"the glegg or filling up is scarce perceptible." But experience has since proved the contrary.

made its appearance, for the flood cannot meet the tide then as it does now, as the weight of water will be pressing against the Dam instead of pressing against the tide. And if the 70,000 tons per minute said to pass the bridge be so much, even with the Frame joined to it, this will in one hour be sufficient to cover upwards of 3000 acres of land one foot deep. By taking the height of a flood at Hanham Wier, and also what I have described it will be at the Dam if built; and comparing a line drawn from one to the other, with the surface of a flood throughout the intermediate space, as it now affects the river; and also with a section of the banks, it will clearly appear, that they must be overflowed from the Engine Mill to Temple Meads.

We should consider the river Avon from the Engine Mills (say 3 miles above Bristol) to the Severn, as a channel made by the friction of the tides against the sides of it. Above the Engine Mill the river water so meets the tide that the force is much lessened, for the run proportionably abates towards the end of its passage. Now supposing the new Dam to be built, this space between the Engine Mill and

the Dam must soon become river size only by filling up, as the water will have no more power to scour there than it has now between Bath and Hanham, nor yet so much. For when this is done it will be one pond from Keynsham Mill tail to the Dam, 10 miles level, except the 4 feet I allowed for fall in the common run * of the river, whereas in the same distance from Bathwick Mill to Keynsham Mills the fall is 30 feet. Therefore floods that are now confined to the channel of the river between the Engine Mill and the Dam will overflow as in other parts above, when the soil and washings of the country have adhered to the banks, and settled in the bed of the river, which will be the case in a few years.

It should be observed that the banks of the river between Bristol and Hanham are not in general so high as at the Quay, and above this to Keynsham only two feet higher on the average. The fall therefore from the Engine

* By the expression Common Current (or Run) of the river, I mean the quantity of water that generally flows about the months of May and June, when the Springs are full; which is about sufficient to keep the Mills fully supplied.

Mill to the mouth of the river, the distance Floods are confined to it, must be produced by the tide cutting the channel deeper in the earth as it approaches the Severn. This large deep channel for a small stream of water, however disagreeable to the sight, is the very circumstance that now preserves us from the effects of a Flood overflowing here as in other parts of the river above.

3rdly.—*Frosts.* With respect to Frosts, certainly there will be inconvenience; the inevitable consequence of any scheme for keeping ships a-float. This circumstance furnishes a strong objection to daming the Avon, as it will leave no means of access to the city by water.

4thly.—*Gouts; Houses, Lands, &c.* The several streets in some parts of Nicholas, Redclift, Thomas, and Temple parishes, being extremely flat and low, a tide 7 feet higher than the Dam mark comes into them, even when there is no land flood, as I have myself recently observed; of course it is matter of serious enquiry by what means the filth accumulating in that quarter can be got rid of; as the termination of the several gouts are in consequence

of the above circumstance near the bed of the river. If it was otherwise a sufficient current could not possibly be obtained. The dreadful effects which will follow if the Dam is built, must be evident to every man, and yet I cannot discover in Jessop's plan any thing like an expedient to obviate them.

Many Pumps are placed near the mouths of these Gouts; the tide now carries off the filth, and the river water is raised clear afterwards; but when there is no current, both must be worked up together.

Further damages to Lands and Houses are described under the head Land-floods.

5thly.—*Getting Ships up and down.* Suppose all the objections from persons holding lands or houses near the banks of the river to be got over, and no floods should require a passage through this sink of the country; there is yet a difficulty which every Merchant and Ship-owner should examine into—that of getting their ships up and down. At present a tide sufficient to bring up a ship of 400 tons burthen to the Mud Docks, flows to Keynsham Mills: consequently there is a current of 12 miles through the Cliffs, where difficulties are ex-

pected : now the Dam being placed only 2 miles above the Cliffs, there can be no more than these 2 miles of current through this place ; and I think it requires no particular penetration to discover that a ship cannot be got up in one tide to Rownham Meads, the entrance of the Lock, a quarter of a mile below the Dam ; for here the current will end, as we may reckon a small run of the river would fill this quarter of a mile, whilst the tide filled the other 8 miles, it being about 3 hours in attaining the greatest height. But (as is frequently the case at Hanham)* if this pond intended to be

* Here the comparison between the intended Dam, and the Dams already on the river, proves a very unfortunate one. When the water is short in the river Avon, the Millers at Hanham work down their head, just before a high tide, as long as the wheels will go round, and by this means lower it near 3 feet ; knowing that the tide will fill this pond again. The tide then opens the Lock, and though the water has only the narrow channel of the Lock to pass through, it will drift a barge half a mile above the Lock, as well and as early on a tide of the same height, as it will to half a mile short of the Lock when the pond is not emptied, that the water might open the gates so early on the tide ; for the water rushing through the gates to fill the river up to Keynsham produces a greater current all the way over the shoals for a mile or two before the barge reaches the Dam.

made by the Dam was emptied to receive a quantity of tide water, a great current must pass the Cliffs and the Lock.

Now in sending a ship down we turn her off at the mouth of the Frome, with 9 miles of water behind, whereas she must be set off at Rownham with only one quarter of a mile of water behind, and the little that will run over the Dam while she is going down; here must be some great exertion to get forward into the current, or the tide will leave her.

It may be said the run of the tide between the Cliffs is too great, and that it ought to be checked; as vessels may then be navigated by using horses on a towing path.

Certainly this is better dependance than on boats rowed by men, and much less expensive; but what power will be necessary to overcome the wind without assistance from the current? We may be told surprising tales of what horses can draw, however this is already ascertained on the Thames, where 16 or 20 horses are used to a barge. Some power besides the current we know is necessary to apply to vessels navigating this river, to make them steer; horses may be used in the present state of it

if a towing path is made, and a small number will answer the purpose.

6thly.—*Sea-water mixing with Land-water.*

With respect to Sea-water mixing with Land-water, this cannot happen but by accident, and the Dam is so contrived that there is hardly a possibility of it; I therefore conceive this objection is of no consequence.

7thly.—*Health of the Inhabitants.* I think it must be allowed that the health of the inhabitants is certainly benefited by the tide scouring up and down the Channel twice a-day; and if the sewers are to discharge into the proposed pond, the foul air must evaporate some way or other.

8thly.—*Counter Currents.* When the tide flows it divides at the mouth of the Frome; and I apprehend more than a proportionate part is forced up to the head of the Quay: the water rising on this inclined plane, and meeting so suddenly with a check, runs back over the surface, and for half an hour before high water a great current downwards is produced; but there is no such effect where the flowing of the tide ceases in the Avon, nor can I pretend to say there will be at the proposed Dam; though

those who entertain this opinion apprehend that the Avon so shortened will be to the Severn, what the Frome is now to the Avon.



The advantages to be derived from a Dock in Canon's Marsh, are, getting ships to their births more safely and upon smaller tides, keeping them constantly a-float, and also spacious Quays in addition to the present.

Against this plan the following objections and difficulties have been urged :—

1. The destruction of Mills on the Frome.
2. The Land-floods.
3. The Frosts.
4. The overflowing the Gouts, and also damages to Houses and Lands.
5. The increased distance from the present Warehouses to the intended new Landing Places.
6. The supply of Water.

1st.—*Mills.* As the supply of water to the Dock must be taken from Bridewell pond, of course the Mill must be purchased; and if a reservoir is wanted, it will be necessary to possess the Mill at Newgate. It should be

considered whether preserving a pond of river water, or letting in the tide is best; the disadvantage of the latter is, that the Docks will want cleansing oftener.

2dly.—*Land-floods.* If Newgate (or Castle) Mills are purchased, and the pond kept as a reservoir to the Dock, the bed of the river may be lowered 3 feet, which will answer the purpose for letting off floods more freely than at present.

An old Moat from this pond through Castle-Ditch to the Avon, may be rendered useful for the purpose, if cleaned and widened. By Jessop's section there is 12 feet fall from the common height of this pond, to the highest flood-mark in the Avon, where it empties itself.* I shall also propose a Culvert 8 or 10 feet diametar, with 10 or 12 feet fall, from the head of the Quay to the mouth of the Frome, to carry off filth, which will likewise take a great deal of the flood.

The quantity of water coming down the Frome in time of flood, bears so small a pro-

* Although the flood in the Avon rises higher than this section states it, yet there will still be sufficient fall.

portion to that in the Avon, I think no doubt can be entertained of the certainty of contriving means to discharge it; for Bridewell and Hanham Mill ponds are nearly level, so are those of Newgate and Keynsham; consequently the fall is as great in a quarter of a mile to the Avon from the Frome, as it is on the Avon itself in a distance of 8 miles and upwards.

A Tunnel may be made, if necessary, from Newgate Mill pond to the Avon, that would carry off all the water; even such a flood as we had the 9th inst. might be got rid of, so as to do no mischief to this part of the town.

These are matters worthy of consideration, even if no improvement be made to the harbour, as it will not in the smallest degree injure the Mills; but it cannot be effected if the Avon be damed.

3rdly.—*Frosts.* Inconveniences will arise from Frosts in this scheme, as admitted in my observations on the other. But the Dock proposed will affect the navigable part of the the Frome only, leaving the Avon open to the tide; and why should we be at so heavy an expence to deprive ourselves of the advantage

nature has given us, and which has hitherto secured our trade without interruption during the severest frosts, as will still be the case if this plan is adopted.

4thly.—*Gouts; Houses and Lands.* In proposing an improvement to the old Quay, I shall explain how the Gouts and Sewers are to be cleansed, and the filth carried off; and as better passages may be made for floods than the present, Lands and Houses will not be damaged.

5thly.—*Distance of Landing-Places from the present Warehouses.* Much stress has been laid on the increased distance to the landing places on Smeaton's canal (as he calls it); and many plans of this sort are burdened with Drawbridges, which I think objectionable. On these particulars I shall further explain myself.

6thly.—*Supply of water.* Smeaton has proposed a mode of supplying the Dock with water so as not to admit the tide, but should the water in the river be insufficient, a little tide-water in a dry season may be occasionally let in, but the less of this the better. Hatches should be placed at the Stone-bridge at the head of the Quay, to keep the Dock water from

going further up, should the tide be admitted occasionally; below this I believe none of the Frome water is ever used.

I am not aware of any other difficulties, except the great expences generally attendant on works of this kind. There are sufficient examples to prove the practicability of Docks, and we are fortunate in a situation where they may be made on comparatively moderate terms.

Now as I have not fully removed all the objections, I hope to do so by proposing a plan somewhat different from Smeaton's, as well as all others I have seen of this kind; in which I endeavour to embrace every object worthy of attention.

I would recommend a Dock 480 yards long, and 220 yards wide, with a bason near the Lime-kiln Glass-house, capable of receiving 15 or 20 ships, and proper gates into the river.* At the end of this Dock next and adjoining to the Quay opposite Farr's Lane, I would leave a tongue or piece of land in the middle of it, as between the new and old Mud

* On examining the ground I find it is just sufficient for the purpose.

Dock, 60 yards in breadth and about 300 yards in length; this would make 14 additional landing places adjoining the present Quay, in a transverse direction to it; there would then be 80 yards wide of water on each side this tongue of land, which is sufficient to take two ships a-breast at either of the landing places, still leaving room for two to be passing up or down; the two outsides of the Dock to the right and left of the tongue will furnish 12 landing places each; a Dam and Bank to be made at the end of the Quay, across the mouth of the Frome 30 yards wide, with Flood-gates to be used in emptying or scouring the Dock.

There will then be in three parallel lines 26 births for landing or shipping goods, accessible from the present Quay with perfect convenience; the other twelve, *viz.* those to the right of the intended Dock will be over the present Draw-bridge; unless it is thought proper that all the Quay room above the broad part of it should be given up to vessels lowering their masts; in which case an Iron bridge may be thrown over the Frome from the Dial Slip to the foot of College-Green, or where the Draw-bridge stands.

I would also improve the present Quay, by building a wall about 30 feet without-side the old one, to the transverse Quay opposite Farr's Lane, from the crooked part above the Crane No. 3 ; and between the new and old wall carry a Culvert to the Avon, which should be brought down from the Stone-bridge at the head of the Quay to this place, between the houses and the present wall, to convey filth from the sewers, as well as water to scour the Dock by side hatches ; and it may be a sufficient size to carry off great part of the Floods, as it might have 12 feet fall in that short distance.

The bottom of this Culvert being level with the bed of the river at the Stone-bridge. which is 16 feet under the surface of the Quay wall ; a very favourable circumstance, as all the Gouts from the opposite side of the river might be brought here (the lowest of them would have 10 feet fall) and passed through the bed of the river, to join the large Culvert on the Quay side. So that no property need be affected in any part of the City, except the Mills before mentioned, and the Lands, Buildings, &c. to be purchased for the Dock and Bason. Dry Docks may be made in much better situations

on the side of the Avon than those are placed in, now on the Frome; as a lower level is attainable.

This Plan I think will remove all the objections founded on the distance of the new Births from the Warehouses, the average is not quite 200 yards from the present Quay; the number of them being thirty-eight (40 yards long each) in addition to the old ones at the Quay, which will be improved in breadth and also afloat. These two circumstances furnish indisputably far more than an equivalent for any benefit to be derived at the Mud Docks and the other Births, between the corner of the Quay and the lower end of the Back, by floating the Avon, besides the accommodations in that quarter will all remain as good as they are now, and may be very useful in times of severe frosts, and on other occasions.

The length of the new landing places being about a mile, and much wider than the old ones, there will be ample accommodation even should the trade of the city be doubled; whereas there will be no more room for business on the scheme of damming the Avon than at present, unless expences are incurred not included in estimate.

There may be two or three good Births for landing in the Bason, if necessary, and two at the lower end of the Dock; this will make the whole of the new Quays just the same length as the old ones, from the Stone-bridge at the head of the Quay to Bristol-bridge. And when we take into the account the inconvenience of many of these, how can we think of being at so much expence and risk to float them; for instance, look at the space from Bristol-bridge to Bridgewater-Slip, where most of the Welch trade is carried on, and see how goods are landed and thrown in the dirt, where there is hardly room for carriages to pass, and of course a remedy is impossible.

The Dock I have proposed will occupy 18 acres, which with a Bason of about 2 acres, is nearly the same surface of water as there is in the highest tide on both rivers between Bristol-bridge and the Stone-bridge, over the Frome at the head of the Quay; and will accommodate 140 of the largest ships that belong, or come to this port, allowing one third of the whole space for passing; besides the present Quay which in fact will be a part of the same Dock.

The top water level I propose to be a little under the surface of Bridewell Mill pond, from whence the Dock is to be supplied; this is about 17 feet on the Quay gage by Jessop's section, and the bottom to be as much lower as will make the whole depth of water at least 20 feet.

The Bason should have two passages into the river, that ships may pass in and out the same tide. Smeaton seems to have intended passing inward-bound vessels one tide, and outward the next, but this arrangement would occasion much inconvenience, which by the addition of one pair of gates to the Bason I recommend, may be obviated. These two pair of gates to shut against the water in the Bason only, but to be always opened by the tide.

Between the Dock and Bason I propose to have two Locks, and in each of these a Stop-gate to prevent the tide water from going into the Dock when higher in the Bason; so that when three or four small ships or trows are coming in or going out, and water scarce, the Bason should not be filled from the Dock but the Lock; by which means a great deal will be saved. Perhaps the water that would

replenish the Bason every tide might not be more than the Frome would regularly supply; if so, the Locks are unnecessary, as a passage with a double Stop-gate must be quite sufficient. A small Lock for Barges and Lighters to pass at all times would be very convenient; and I think by proper care both the tide and muddy water from the river may be kept out of the Dock.

It appears by the "Further Explanation of
 "the Dam and Works proposed to be erected
 "across the river Avon at Rownham Meads,
 "published by order of the Corporation of the
 "City, and the Society of Merchant-Venturers,
 "in the year 1793," they flatter themselves "a
 "free communication may be opened between
 "the Quays and Kingroad, on every day in
 "the year, Wind and Weather permitting,
 "for all vessels usually frequenting the port."

In any plan which admits the tide to pass by Rownham with the same current to assist the shipping up and down as at present, there can be very few instances of delay from this place; but the Dam proposed will destroy the great effect of the tide, which is the principal agent in the business; and the power that can be

applied on a towing path, though it might prove a useful helpmate, cannot be sufficient to replace it.*

Now whether vessels enter a Bason near Rownham, or the Lime-kiln Glass-house, on an open river scheme, is not very material except in point of expence, which must be in favour of the latter, for here the bed of the river is under the level Jessop proposes to place the threshold of his lower Lock.

The smallest tide is 15 feet deep, and flows near 4 miles above, therefore with the assistance of this current we may depend on the greatest part of the shipping that frequent the port, going out and coming in without any hindrance from want of water, and there will be very few instances in a Spring where the quantity may not be sufficient to navigate the largest. The Bason I propose will then admit ships

* I consider the power of one horse on a towing path equal to 24 men rowing in a boat; comparatively it is more in favour of the horse against a current, but the same number of men rowing have the advantage down stream, though it must be rapid to make either material; the horse loses power also in sharp turnings, as the line forms a greater angle from his draft,

on about 9 feet less tide than the three lower births at the Quay, or the Mud Docks; and if the thresholds of the Gates are placed 4 feet above the bed of the river they will then be 30 feet under the level of the surface of the Quay wall at the lower corner.

Many other plans have been proposed which I have not noticed; some intended in Canon's Marsh, so little digested that they are represented to contain more ships than the whole Marsh will stow, and generally no mode pointed out for supplying the Dock with water. A scheme for making a Cut to carry off Floods and waste water from Temple Meads to Redclift, requires so much removal of earth that when the number of cubic yards are calculated, it must be abandoned. Another, though shorter passage from Wapping to Redclift, would cost more in cutting than the Dock, and no additional Quays without going down the old river to make them; besides neither the expence nor any other objection to daming the river removed.

Queen-Square is a situation which has often been mentioned as a spacious and convenient place for shipping. If we leave about 90 feet round the outside for a Quay, we shall have

$3\frac{1}{2}$ acres for water ; there will be room in the first tier for 11 large ships three on each side, except that where the entrance is made which can take only two, and 11 smaller may be stowed off-side—but what expence must it be to make a proper communication between this and Kingroad ? Others are for pulling down part of Princes-Street ; but why waste the money in this way, when we have room to make greater improvements without it.

I have now to examine and compare the expences of executing—and means of raising the money. I have already mentioned Smeaton and Champion's estimates. The Corporation and Society of Merchants in their explanation of the Dam and works, say—‘ Mr. Jessop has ‘ given the following, founded on his experience ‘ in other works, compared [with the prices of ‘ labour and materials in this part of the kingdom :

‘ Canal and Locks 25,013 *l*.

‘ Circular Lock 8,173

‘ Dam 13,938

‘ Contingencies 4,712

‘ The purchase of Lands, Indemnifications,
‘ &c. &c. are not estimated with sufficient accu-

‘ racy to lay before the public ; but it is believed
 ‘ on good grounds that 100,000*l.* will be more
 ‘ than sufficient to complete the works, and
 ‘ fully indemnify all whose property may be
 ‘ affected by them.’

Lands that are used for the purpose of cutting the Canal, Roads, &c. also Mills and Dry Docks, which are destroyed entirely ; the making of Drains from such as may remain, or from the mouths of the Gouts, may be valued ; but the injury to whole parishes which are liable to be covered by floods occasionally, and that have the Gouts constantly buried under water, to a City deprived of its necessary evacuations, must exceed all calculation. And I am inclined to think that the Mills destroyed, Lands used, and other things indispensably necessary, will, with the increased price of labour and materials, amount to a much larger sum than the 100,000*l.* last mentioned ; without reverting to the damages which the proposer seems not at all aware of.

As Smeaton’s scheme seems to be on too limited a scale, I will compare what I have proposed to Jessop’s plan for damming the Avon.

First. There are more Locks and Gates necessary in the daming the rivers, than in the Dock scheme.

Second. There are a greater number of cubic yards of masonry, rubble-stone wrecked with gravel and rammed by a piling engine in the Dam, than will build a mile of Quay or Dock wall 30 feet high, 6 feet thick in the bottom, and four feet at the top.

Third. The digging of Jessop's canal, foundation for Locks, and lowering some parts of the Avon, will cost near half so much as the Dock and Bason. The sum necessary to purchase Hanham and other Mills on that river is fully sufficient to complete them.

Fourth. Bridewell-Mills must be destroyed by daming the rivers, which would not be the case in the other scheme; yet as the water is taken to supply the Dock, this expence will be alike in both; so in respect to the dry Docks, and any other property on the navigable part of the Frome: but above the Stone-bridge no alteration will be made by the Dock scheme.

Fifth. The dry Docks on the Avon, the value of land at Rownham Meadows, and damages of various kinds would altogether

amount to a sum sufficient for the purchase of land for the Docks. If the dry Docks above mentioned are not bought, there must be two Drains from them, each about a mile and a quarter long; perhaps its better to buy this property than make the Drains.

Sixth. If the rivers are dammed, some new course ought to be found for the sink of the whole city: and this must be carried to Redcliff to obtain a current, but I doubt whether there is sufficient for the distance.

The drain for Sewers in the Dock scheme will be very small comparatively, as it will only be wanted from one end of the Quay to the other; and the Avon being open all the filth will pass off as at present.

Seventh. The timber work in the Dam, viz. Gates against the tide, Flood-hatches, the 36 apertures with falling doors, the Piles, &c. will more than completely pay the expence of getting rid of the superfluous water flowing down the Frome in times of flood, so that it may never affect the Dock. The City also will be relieved from the inconvenience it at present suffers by freshes in that river.

Eighth. The expence of cleaning the Dock will bear no comparison, as neither tide water nor land-floods will be admitted into it; and if no drains are made for the Sewers in the Avon scheme, there will be the accumulation of filth of every kind from these, as well as the land-floods. The Canal also admits tide-water up to the circular Lock; the keeping this clean (if possible) will be an immense expence. A Canal cut level with the river at Gloucester was filled in a very short time with mud, so as to be rendered useless.

Ninth. John Champion has proposed in his Dock scheme, to erect Mills at the end of the Quay, or at the lower end of the Dock; but I think if the Dock is supplied with water from the river, the surplus will not be worth any thing for this purpose; and if supplied by the tide the disadvantage of filling the Dock with mud will overbalance the advantage of a Tide-mill, the time of working being so very uncertain.

Wm. Champion in daming the Avon has the advantage in this case; more water and a greater fall may be obtained. But laying the foundation of the Dam on Piles 100 feet by

330 in the bed of the river, will be an incalculable expence and risk; a new passage for the land-water must be cut while it is doing, and its very uncertain how long the trade must be stopped. I therefore conclude the Dock scheme, even on my extended plan, is least expensive; and that it is within the bounds of calculation by men of experience, but doubt whether the other is or not.

In the Explanation given by the Corporation and Society of Merchants, a tonnage on shipping that shall produce 5150*l.* per annum, and a toll on the bridge 500*l.* per annum, is proposed to defray the expence of the undertaking, and provide a fund for the discharge of the debt. If the money is to be borrowed, which I suppose they mean to do, a fund derived from these sources will not pay the interest, much less provide for the discharge of the debt; but some other mode must be adopted to raise a further sum even to pay the interest. Repairs and cleansing are not noticed.

But why not raise the money by subscription, doubtless there are Speculators sufficient to subscribe to a good plan.

To complete Bristol-bridge, and the improvements near it, a considerable sum of money was drawn from the shipping by taxation ; and it has been suggested (I think with justice and reason) that this ought to be paid back again by the Citizens who daily reap the benefit of these accommodations ; a limited tax on houses for this purpose should not be objected to.

I wish to have it understood that no reflection on the Engineer employed in the scheme for daming the Avon, is intended by me ; his character stands too high for any thing I can say to affect it. I find no fault except with the line of a Land-flood drawn in the section ; it does not represent one of the highest ; for that I have already mentioned which happened the 10th instant, brought down three times the quantity of water, and there has been another since on the 25th still higher : in this he must be misled by information, for it cannot be supposed that either he or his Surveyor could be present in every state of the river.

If the Corporation and Merchants, instead of consulting on which is the best mode of daming the rivers, will submit the different plans for improving the Harbour to their

Engineer, and another named by the Citizens; requesting them to make a report thereon, and also to answer the objections made by owners and occupiers of Lands and Houses to the scheme they shall recommend, it may save much trouble to the parties interested.

— If some good plan was carried into effect, I think it likely the trade and credit of the city of Bristol would revive, and a general spirit of enterprize be diffused. We are united in the opinion that the Harbour wants to be improved. Let us submit to the judgment of proper men, and unite in the measure they shall determine on, and the business will be half done. Don't let one party go to Parliament with a scheme, and another party meet them there with a different one, and by that means let the whole fall to the ground. Nor try a project which we shall be obliged to abandon after spending 100,000*l.* as such conduct must subject us to be laughed at by all the world.

30th of November, 1800.

FURTHER REMARKS
ON FLOODS AND COUNTER CURRENTS.

In reply to an observation lately made—
 “That when Land-floods are pen’d back by
 “a Dam, and brought nearer the surface of the
 “Channel which is so much wider at the top
 “than in the bottom, there will be less current,
 “and sufficient room to pass off without over-
 “flowing the Banks.”—In order to ascertain
 whether the fact be so or not, let us first find
 out the decrease of current, then compare this
 and contents of the cross section of the channel
 of the river above the level of the Dam, to the
 present current and the room which the flood
 now takes up in different parts of the river.

The fall from the surface of a flood 15 feet
 on Hanham Weir to the bed of the river at
 Redclift is 44 feet. The new Dam will take
 away 24 feet of it; if to the 20 feet remaining
 we add 4 feet for the increased height at Han-
 ham, we shall have half the pressure, the friction

likewise may be so much less in proportion ; then if the water moves with half the velocity, of course it will require double the space ; this under Bristol-bridge, measuring from the crown of the arches downward will come to a point 3 feet below the level of the surface of the Dam, (we cannot gain room upwards without re-building the bridge.) It may be said the flood-hatches at the sides of the Dam will make the under point of motion of the water lower ; but I think not equal to this 3 feet ; to get double the water way at Temple Backs we must have 3 feet height above the banks ; at the farther end of Temple Meads still more, and as we proceed up the Marsh on the other side the river a Flood in its present state will rise within 2 feet of overflowing, without any tide to assist. Hence it appears we may have an opportunity of passing in boats from place to place through some of the streets in the lower part of the town.

Any person riding to Bath may observe the water at the river side in Keynsham Hams 5 or 6 feet high on the banks when its within bounds between Saltford and Bath. This will confirm my remarks on the fall from Bathwick

to Keynsham being so much more than from Keynsham to the River's mouth; and it must be clear that ever so little stoppage below will increase the effects of the flood in these meadows.

I have dwelt so much on Land-floods because it appeared to me the consequences are certain and easily calculated; the effect of Counter-currents are more speculative; but as many observations worth attention have been made on this subject, I will lay them before my readers for their investigation and judgment. This Current begins about one third tide, or just at the time it reaches the flood-hatches at Bridewell-Mills, and increases so as to be very strong half an hour before high water, when a ship should be getting to her birth at the Quay, continuing throughout the remainder of the tide; its great force is at the mouth of the Frome and decreases upward. When little or no water flows down the river the greatest effect is produced, and should there be Fresh enough in the Frome to fill between Bridewell Mills and the Mouth as fast as the tide rises in the Avon, no such current is produced; so in proportion to the greater quantity going

down the river and smaller tide coming up, is this effect lessened.

Some say the water runs upward in the bottom of the river, and downward on the top. Others contend it is an eddy, and runs upward on the Quay side, and downward the opposite—experiments are in favour of the former; perhaps the current may be deeper on that side where it is strongest, as we may observe that one is more so than the other.

One party contends the intended Dam will produce a counter current, and expects it at the mouth of the Avon; whilst another who says it will not, is looking for it at the Dam. Both these parties may be right as far as they examine their own ideas of the business, and have no patience to attend to the others; the present effects are sufficient to determine there will be none at the latter place. The example at the mouth of the Frome would prove what may be produced at that of the Avon, only the distance from the mouth to the Dam in the latter case is so much more than the former. But the other party says—the Severn being so large a river, and receiving such a great body of water the counter current may be produced

at the mouth of the Avon; for the level of the bed of the river at Bridewell hatches is 10 feet higher than the mouth of the Frome, and where the Dam is intended to be built it is no more than 10 feet above the mouth of the Avon.

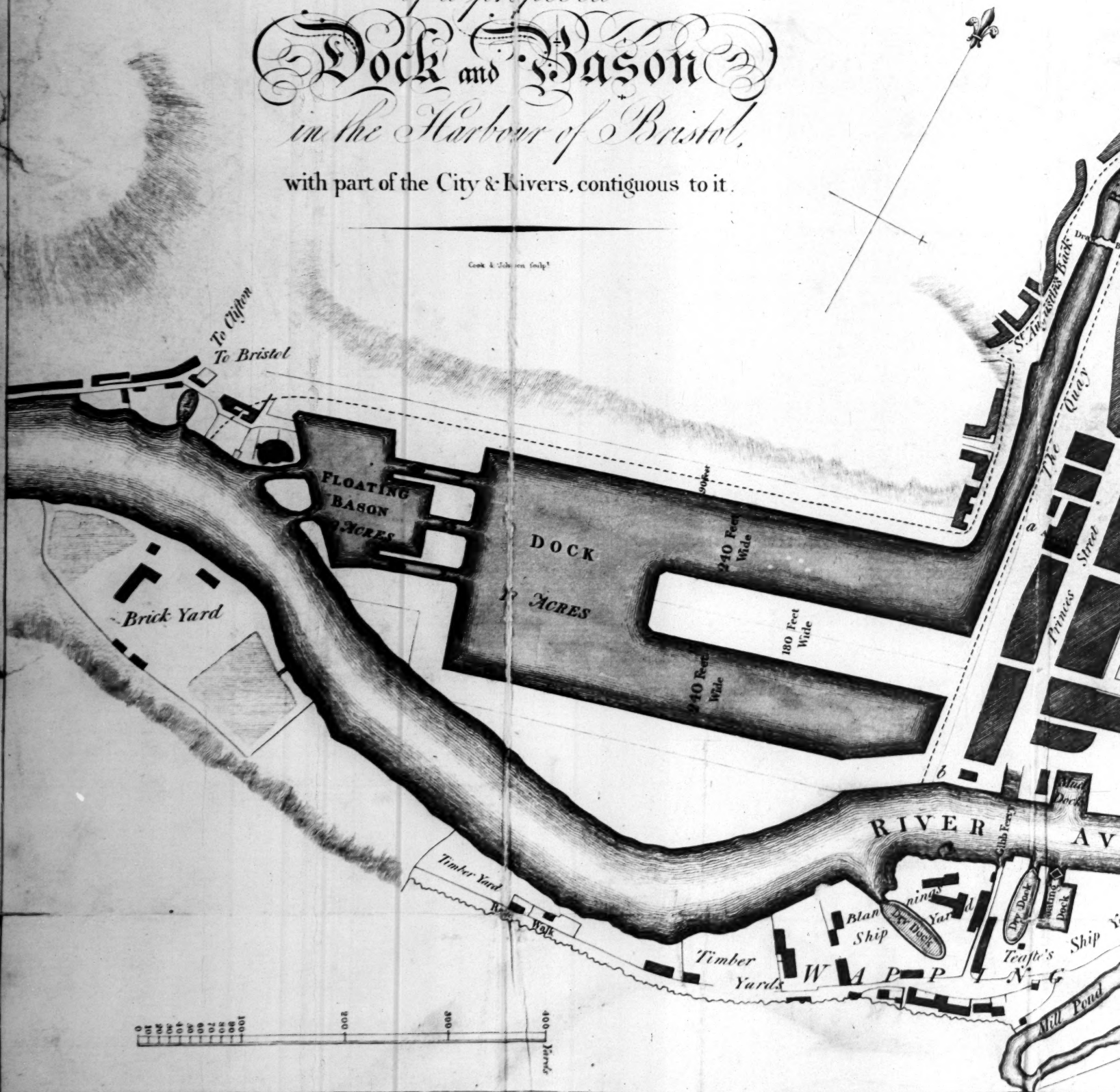
In speaking of levels I have kept to whole numbers in feet, not conceiving it necessary to trouble my readers with fractions; but I have in no instance endeavoured to make more or less to favour any plan.

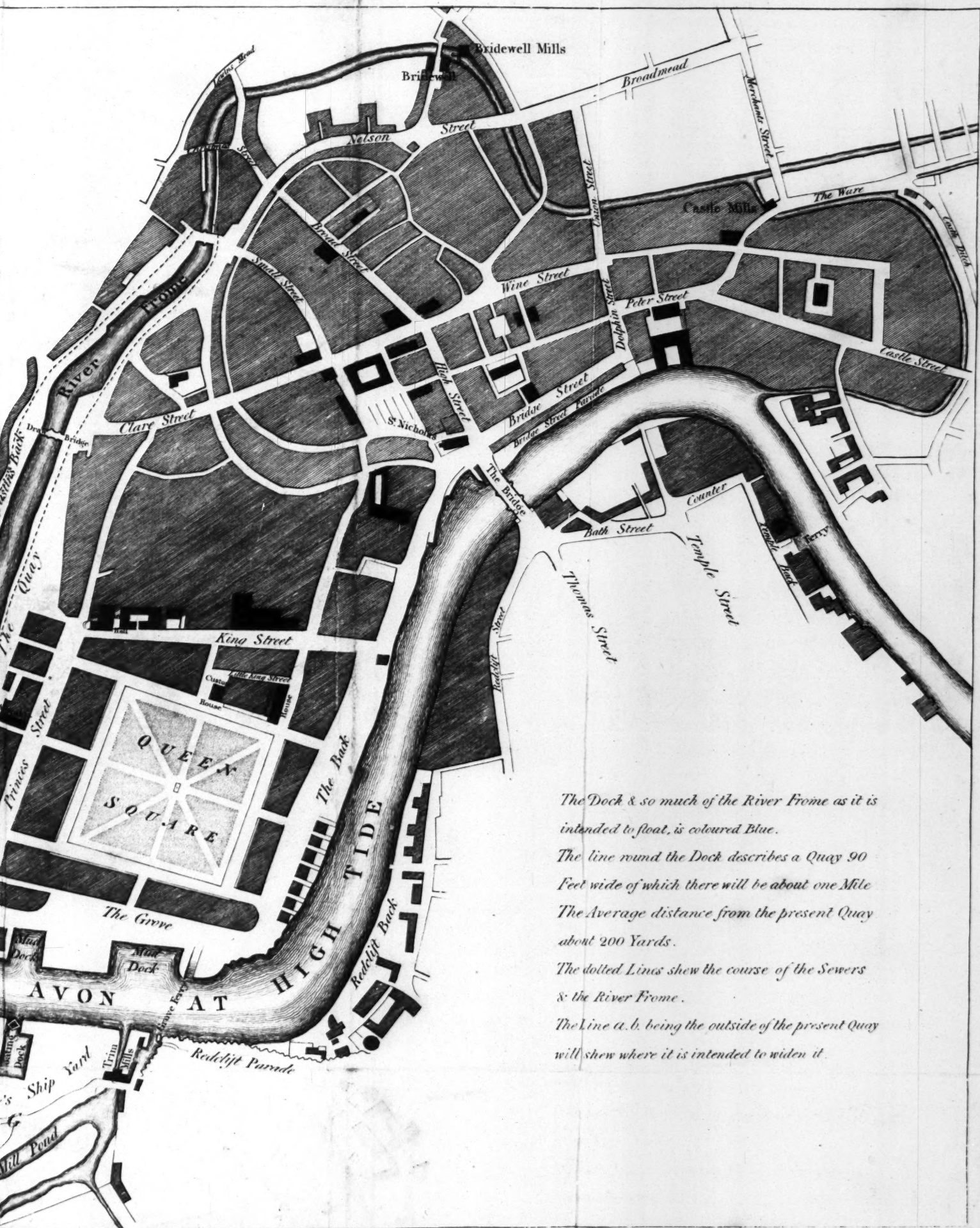


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PLAN
of a proposed
Dock and Bason
in the Harbour of Bristol,
 with part of the City & Rivers, contiguous to it.

Cook & Johnson Engrs





The Dock & so much of the River Frome as it is intended to float, is coloured Blue.

The line round the Dock describes a Quay 90 Feet wide of which there will be about one Mile The Average distance from the present Quay about 200 Yards.

The dotted Lines shew the course of the Sewers & the River Frome.

The Line a. b. being the outside of the present Quay will shew where it is intended to widen it.